The Design and Development of Aquatic Exercise Shoe Flaps

by

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Submitted to the Department of Mechanical Engineering in Partial Fulfillment of the Requirements for the Degree of

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ABSTRACT

A foam structure that is attached to the bottom of a shoe worn while exercising in the water was designed, developed, and prototyped. The structure freely bends downward so as to provide little resistance when the foot is raised, but is resistant to bending upward when the foot is pressed down, thereby increasing resistance and enhancing the in-water exercise effect. The structure is called AquaFlaps.

Several sketch models were made in the development of the idea leading to several foam prototypes created using the water jet. Testing of these models and prototypes yielded useful data which helped towards the final design. Testing also demonstrated that the product achieves the desired results. A provisional patent was filed.

Thesis Supervisor: Alexander H. Slocum
Title: Professor of Mechanical Engineering

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1.0 Introduction

1.1 Background and Objective

Athletic training is a concept that has been known to man for centuries. It began simply with the lifting of heavy objects as well as with walking and running. It has since evolved, allowing for athletic training far beyond what could have been done twenty or thirty years ago. There are machines and exercises in existence today for almost anything imaginable. Despite these technological improvements made to the fitness world, there is still an incredible potential for exercises to be created. One such example is athletic training in a swimming pool. Only recently has there been a focus on exploring the possibilities that water workouts could provide. The Aquajogger belt (http://www.aquajogger.com/) in particular is a device now commonplace in most swim facilities, providing upright flotation so that one may run through the water. Additionally, many have explored adding paddles and weights to the hands or ankles to provide a more intense water workout.

For any semi-serious college hockey player, it is generally required to follow an off-season workout program in order to get in shape or keep in shape for the upcoming hockey season. Most programs involve weight lifting, running, and other land exercises to work the legs. Personal experience has suggested that even while doing everything outlined in the off-season workout program, the legs are still not adequately prepared when the first practice rolls around to begin the new season. Attempts at rollerblading, running, and biking have all yielded similar results. The conclusion reached is that the best way to get in shape for ice hockey is to skate in the off season. The big problem for some is that many ice rinks shut down during the summer months or do not offer competitive summer programs in which to participate. The only option is to train off the ice.

The initial objective of this project was to find a way in which to bring the ice skating motion to a new environment, the swimming pool, both cheaply and effectively. This would allow for players who do not have access to an ice rink to train or allow those who need additional training beyond what can be achieved in a gym to get it. As the product was developed, however, the target user switched to everyday people who enjoy low impact workouts that a pool provides. Essentially it will be another pool targeted workout device that may become commonplace at many pool facilities. For safety, it should be used in tandem with the Aquajogger belt and may also be used for rehabilitation techniques.

1.2 Physical Intelligence Dimension

Physical intelligence is the ability of the human organism to function in extraordinary accord with its physical environment. The body and all of its sensing, thinking, and moving is the basis of the life experience. By using water as a medium in which to exercise, it creates a whole new environment for the body to experience, especially when the point of the exercise is not to swim in the water, but to be upright and ice skating, running, or pedaling up and down. Traditional leg exercises done in a gym target one muscle group at a time and don't incorporate full body movement. By using water as a medium in which to exercise, the body must adapt itself and incorporate the entire body to balance and stay afloat. The body must learn the environment and act accordingly, demonstrating physical intelligence. Additionally, the body must figure out how to use the exercise device in the water. It is not as simple as sitting in a nautilus machine and pulling a bar down in a predetermined motion.

2.0 Apparatus

2.1 Thought and Design Process

The design process began by simply going to a swimming pool and trying out different motions in the water to see what kinds of motions were sustainable and desirable. Although Aquajogging is gaining popularity, the legs do not get the same workout as on land. Following this, some simple hand sketches were drawn of devices that could be worn on the feet to increase the resistance of the water on the leg muscles. The concept explored most was that of a hinged device which, when the leg pushes out, will have flaps that flip up and increase the overall surface area of the device. This in turn will increase the resistance and make the pushing motion more strenuous. Then, when the leg pulls back in, the hinged flaps will flip down and the device will return to its normal boot state and only have the resistance of the boot. The next step was then to convert the concept into a physical model in order to see how well it might work.

2.1a Sketch Models

The initial sketch model was about as simple as it could get while still demonstrating the concept. A device was made out of wood, hinges, nuts, bolts, and bungey cords. Figure 1 shows a top view of the device where the blue bungey cord straps are for strapping the foot onto the wood plank. Figure 2 is a side shot of the model. The slanted piece of wood to the right is the hinged flap and it can be seen that it can only flap up until it contacts the metal brackets (i.e. when the flap is a continuation of the plank on which the foot is strapped) as shown in Figure 3. It also can be noted that the flap can never flip up in the wrong direction since the vertical plank shown in Figure 2 will prevent that.

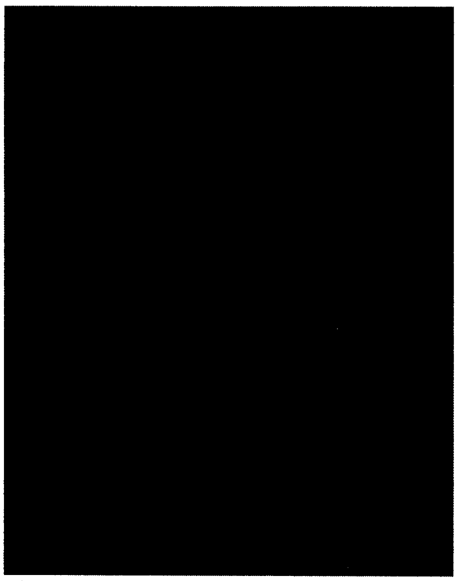


Figure 1: Top view of first sketch model

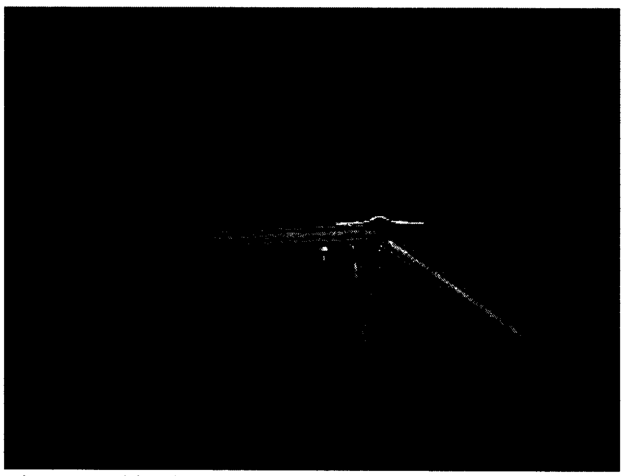


Figure 2: Side view of the first sketch model

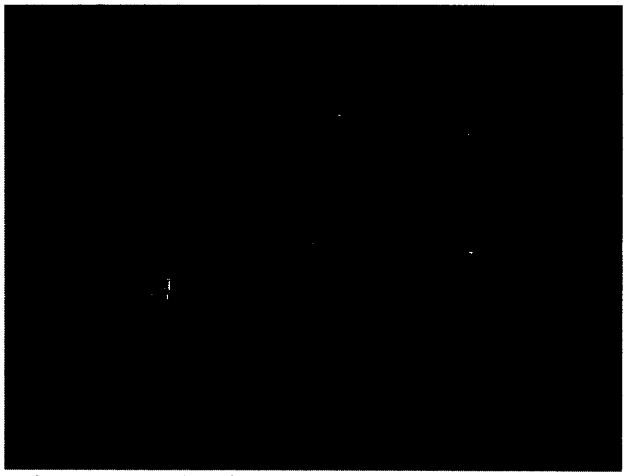


Figure 3: Top view first sketch model with flap extended

This sketch model was utilized in the pool and several important observations were made. The first observation was that the added surface area did in fact increase the resistance although for this particular model it did not increase it by too much. A second observation was that the hinged concept worked quite well. As the leg pushed out, the flap went up to the metal bracket which stopped the flap flush with the footbed, thus maximizing the surface area over which the water can act. When the leg was pulled in, the opposite happened. The flap folded down and the resistance was reduced to that of what was caused by just the foot area. A third observation was that the bungey cord straps were uncomfortable and so would not suffice for further sketch models and mockups. Finally, it was somewhat awkward to have the extra resistance distributed to only one side of the foot. It was not clear whether this problem would be solved by a more supportive boot but for future models it was determined that the added resistance should be distributed evenly around both sides of the foot.

The next sketch model was much improved in several areas. Again, it was made out of wood, metal hinges, nuts and bolts which was less than ideal for the actual prototype.

However, being a sketch model, these materials work well enough to gain useful feedback. The first big improvement of this sketch model was the boot. The boot pictured is a wakeboarding binding borrowed from a personal wakeboard. Although the wakeboarding boot, designed for incredible ankle support, was much more than was needed for this application, it was a quick solution to an otherwise difficult problem. The boot was attached with just a nut and a bolt using the clamp that the boot came with. Another improvement to this sketch model was the added flaps. With flaps around the entire center foot bed, four in total, the resistance achieved was expected to improve significantly. Additionally, the flaps being even on opposite sides of the foot bed would solve the problem of having an uneven resistance distribution around the foot. Figures 4 and 5 illustrate this improved sketch model and show the flaps in both the up and down configurations. Figure 6 shows the bottom view of the device and the hardware used for connecting the parts. Figure 7 shows a hinge and a brace bent slightly greater than 90 degrees in order to prevent the flap from folding up the wrong way.

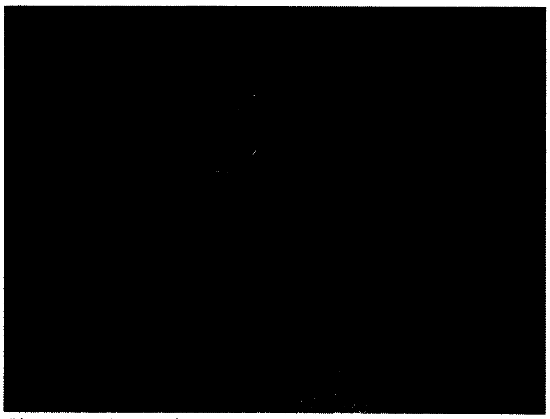


Figure 4: Second sketch model with flaps down

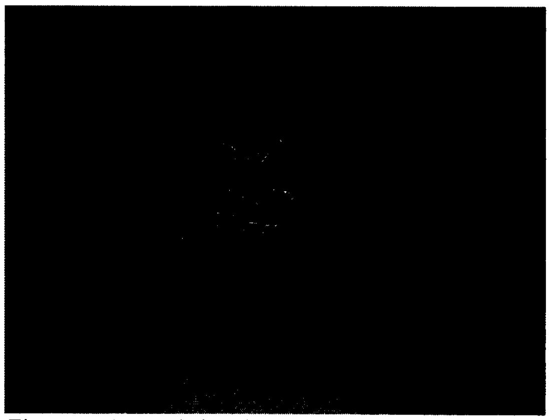


Figure 5: Second sketch model with flaps up

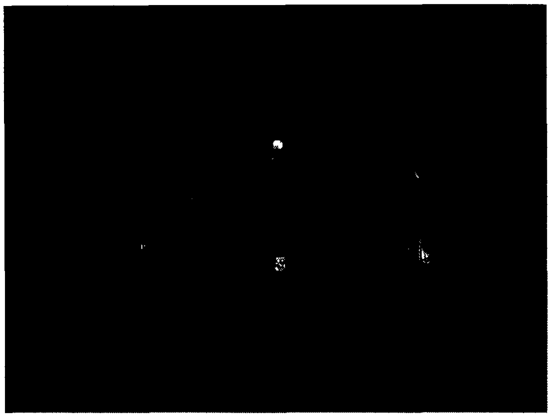


Figure 6: Bottom view of second sketch model

Figure 7: Close up of hardware used

After testing this sketch model numerous improvements were noted. The most notable improvements were the much more supportive boot and the greater resistance gained from the additional flaps. Despite these betterments, there were still problems that arose from the sketch model. The first problem was the width of the device when the flaps were extended out fully. The width was so great that when using the device it was extremely easy to hit the lower part of the opposite leg with the inside flap which caused significant discomfort. Another issue, although not as significant, was the observation that the flaps did not all extend out at the same time. This would depend on how the leg was pushed out against the water. When the flaps hit their stops at different times, the result was a displeasing series of clicks felt by the foot.

The third and final sketch model attempted to solve these final problems. After thinking about other ways in which to achieve greater resistances in one direction while minimizing it in the other, a final idea was hatched which was not unlike the previous sketch models. The major change was to reduce the number of flaps from four, to two. The flaps would be hinged under the boot and then designed to extend up from there.

Figures 8 and 9 illustrate this new design in the up and down flap orientations. By hinging the two flaps underneath the boot as opposed to the sides of the boots allows for a reduced width when the flaps are down. This will solve the problem of hitting the other leg with the device. The two flaps also eliminate the displeasing clicks when the flaps extend up and hit the stops. Additionally, the bottom of the boot acts as the stop. This, combined with the fact that there were only two hinged flaps significantly reduced the hardware necessary to create the mockup. Figure 10 shows the bottom of the sketch model and the reduction of hardware.

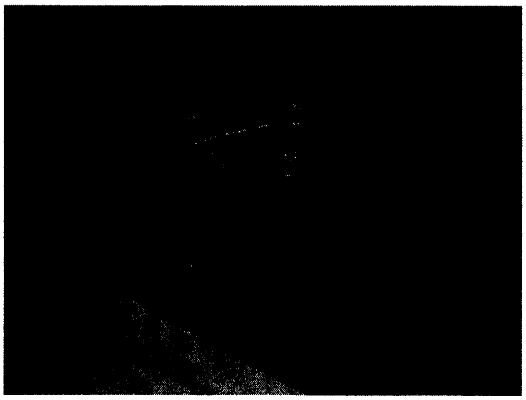


Figure 8: Third sketch model in extended position

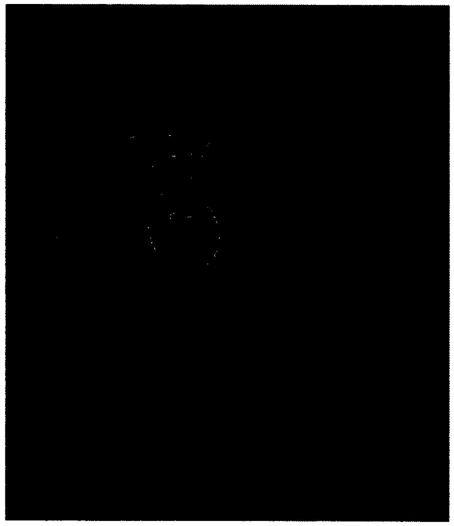


Figure 9: Third sketch model with flaps down

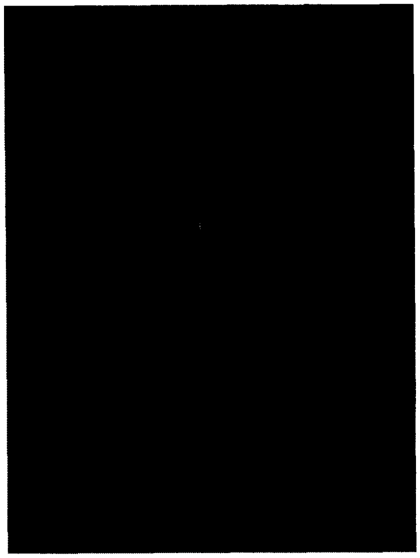


Figure 10: Bottom view of third sketch model

In addition to being much easier to assemble, the testing of this third sketch model yielded excellent results. The width was now adequate so as to avoid hitting the opposite lower leg. With two flaps there were no displeasing clicks as the flaps hit the stops, which were in this case the bottom of the boot. The main question now was what materials were to be used to prototype the water device.

2.1b Materials Selection

In considering what materials to use for the device, it is necessary to be reminded of the fact that this device will be used in water. Therefore, using metal for any part of the device will not be adequate since the metal will rust. Additionally, metal could potentially be a safety hazard. Another point to consider is the buoyancy of the material. Metal will sink and thus work against the goal of the project, which is to have increased resistance going down, not up. Preliminary thoughts involved continuing to use the wakeboarding boot for the prototype and use a material such as delrin or polycarbonate for the flaps. The major technical issue in this plan is how to hinge the plastic without using the metal hinges. Upon thinking further, other issues also arose. For one, the cost of these materials would be rather expensive. For a device such as this, the price needs to be as inexpensive as possible to be marketable.

Upon talking with Professor Slocum, it was decided to make the entire device out of foam. The foam to be used is the same type as that used for the water noodles found at most swimming pool facilities. Using foam would allow for several things. First, it solves the hinging problem. The foam itself is flexible and thus becomes its own living hinge. From a cost standpoint, foam is also inexpensive, which will make the device marketable. From a manufacturing standpoint, using foam will allow the material to be die cut which makes the device very easy to produce. Despite these advantages, using foam also had its downsides. For one, making a boot out of foam was not going to be easy. Additionally, connecting foam pieces together also presented a challenge since most adhesives will simply peel off in water. Despite these potential challenges, foam still was deemed the best material to use and in this way, the prototyping began.

2.2 Prototyping

Before the prototyping could begin, it was first necessary to make solid models of the potential designs using Solidworks. Once the solid model was created, the pieces of the prototype could be made using the waterjet. It was also essential to research current water boots already on the market. Doing this research proved extremely useful as it was found that Aquajogger makes foam boots called Aquarunners which are supposed to be used to provide added resistance to an aquajogging workout. As it turned out, the Aquarunners were exactly what was needed for the boot piece of the device. As an added bonus, in the bottom of the boot there was already holes cutout which would make connecting the boot to the flaps much easier. Thus, the only pieces that needed to be designed and prototyped were the flaps and the piece to connect the boot to the flaps. To get an idea of what the device looks like, Figure 11 shows an example of a completed prototype.

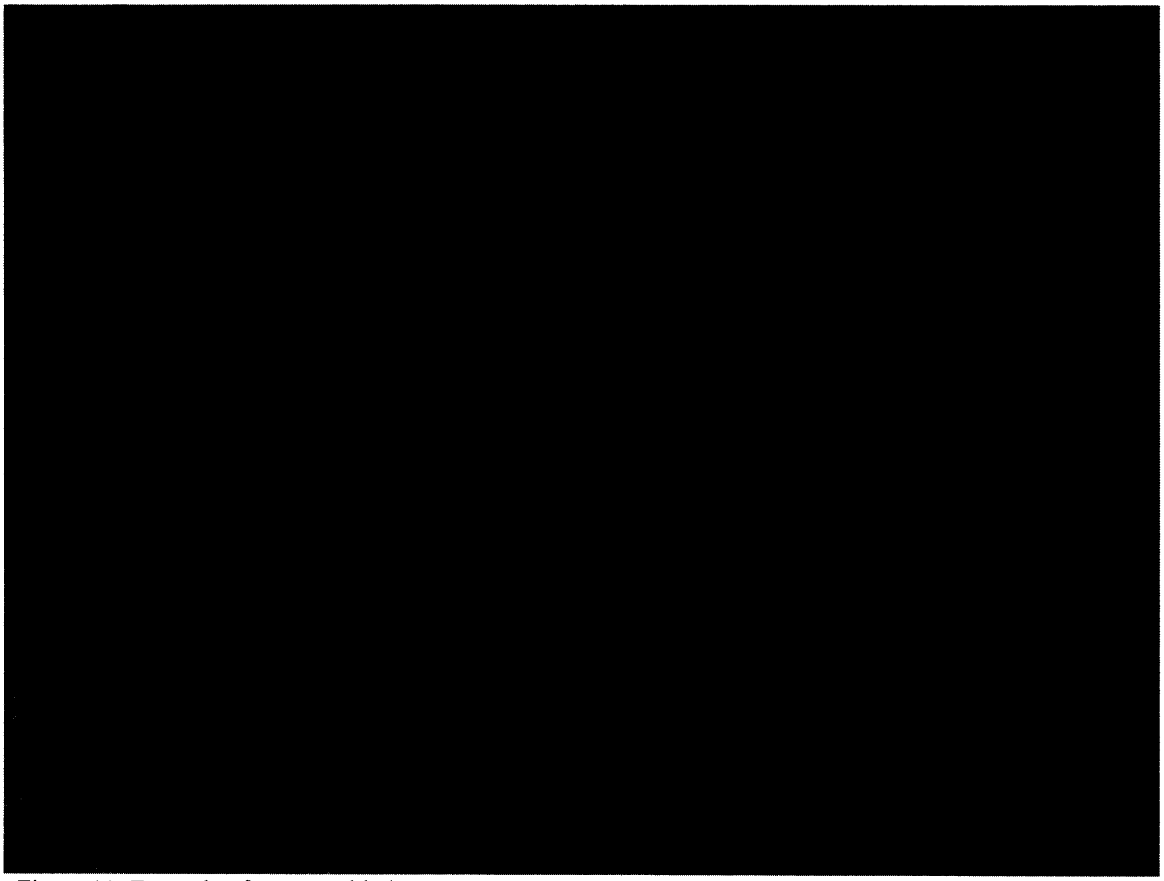


Figure 11: Example of an assembled prototype

2.2a The Flaps

The flaps were prototyped using kickboards. The idea for the prototype was to cut out two slots in the very center into which a pin could slide in tightly and connect the boot to the flaps. Around these two square holes there were to be more holes cut out in various shapes in order to take some of the stiffness out of the kickboard and make the flaps more flexible. The first prototypes of the flaps made using the waterjet are shown side by side in Figure 12 below. The prototype on the left has thinner connector pieces than those of the prototype on the right (connector pieces are the thin strips of material connecting the square holes in the center to the solid foam flaps).

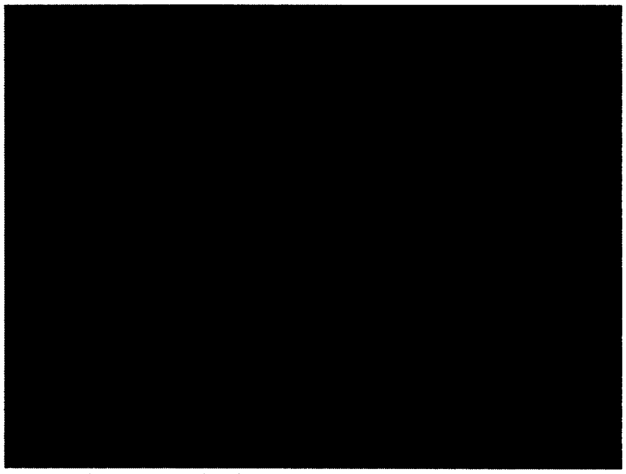


Figure 12: The first two prototypes of the flaps

After testing both of these models, it was clear that all of the connector pieces needed to be wider. Figures 13 and 14 illustrate that the connectors were much too thin and ripped rather easily. Figure 14 demonstrates the flexibility of the flaps in addition to showing the ripped connectors. Even the prototype with wider connectors ripped, albeit not in the same location. This prototype ripped in the foam that forms the square pin holes.

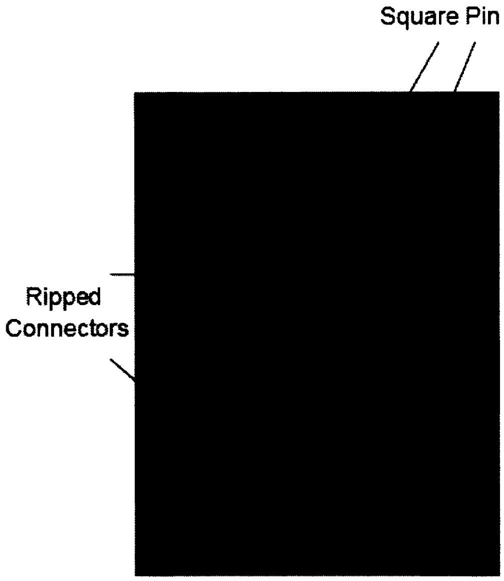


Figure 13: Close up of ripped connectors

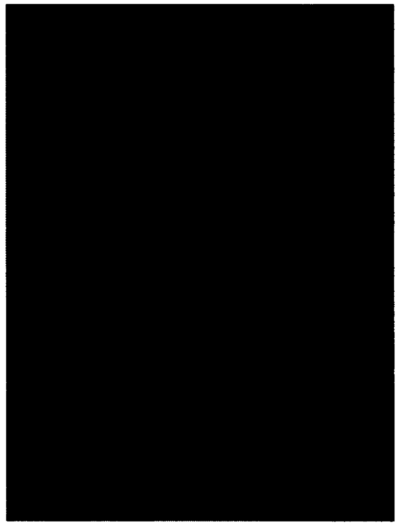


Figure 14: Close up of flexing flaps

After making and testing these two prototypes it was clear that an excessive amount of force was put on these narrow parts, and to be successful, these narrow sections of foam would need to be widened significantly or eliminated altogether. Another observation noted from testing was that the buoyancy of the foam provided additional resistance and so although the flap size was smaller (compared to the sketch models), the resistance achieved was still comparable. Furthermore, while testing it was noted that since the feet are more buoyant than the user's midsection, the prototypes tended to pull the feet up above the midsection which could lead to panic and safety issues. However, for more experienced users, this could add excitement and teach better balance. From this point on it was assumed that these devices would be used in conjunction with a large flotation belt commonly used for aquatic jogging.

Using this data, the next prototype made was one without any cutouts surrounding the square pin holes. Figure 15 shows this pattern and Figure 16 shows the previous pattern.

From these bottom views it can also be seen how the pins function to hold the boot in place. The pin for this design, to be discussed later, slides into two holes in the bottom of the boot and then through the square pin holes cut out of the foam as shown in Figures 15 and 16. The idea is that the barbs will hold the boot to the flaps.

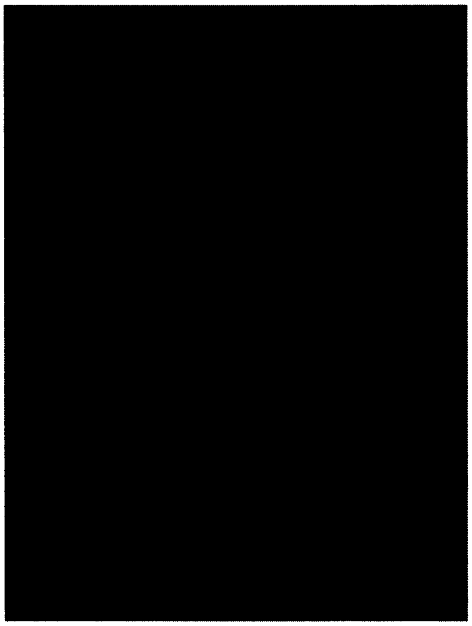


Figure 15: Bottom view of third prototype

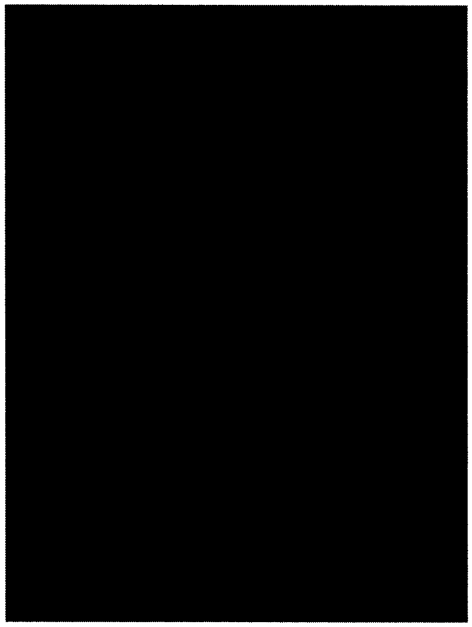


Figure 16: Bottom view of second prototype

After testing the third prototype several observations could be made. The most notable was the stiffness of the flaps. Although still flexible, there was a definite contrast when compared to the flexibility of the prototype displayed in Figure 16. The added resistance when pulling the leg back to the body due to the stiffer flaps was significant. The ideal model must be found somewhere between the two extremes. Another observation common to all of the prototypes was that when pushing out against the water, there was nothing to prevent the flaps from flexing further than they should. This is not ideal because the flaps will not be as flat as they could be and some surface area will then be lost, leading to an unnecessary decrease in the resistance created by the device.

To solve the flexibility problem, it was decided that there should be some holes cut out around the square pin holes, but the amount of material to be cut out did not need to be nearly as much as that in the prototypes shown in Figure 12. Additionally, to solve the problem of the overextending flaps it was decided to add one-way stoppers to the flaps that would lock into place when the flaps extended and were flat. Although not prototyped, Figure 17 shows a solid model of what the next flap design would look like. There is only one center hole due to the redesign of the pin which will be discussed in the next section. Figure 18 is a model of what the stoppers would look like.

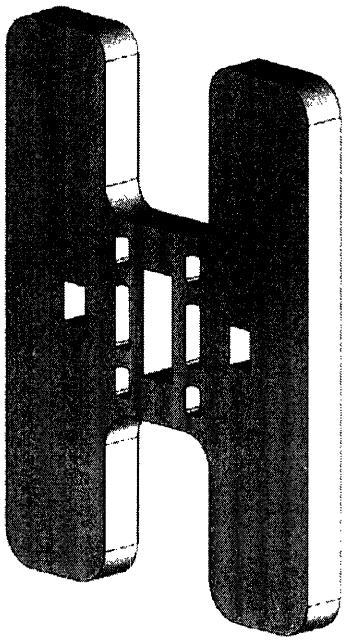


Figure 17: Redesign of the flaps

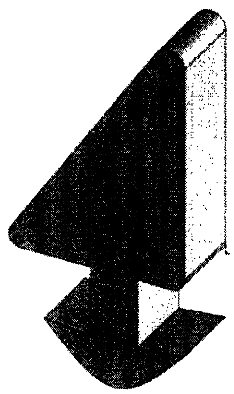


Figure 18: Solid model of the stoppers

2.2b The Pin

The pin design was all based on the tab design suggested by Professor Slocum shown in Figure 18 above. Since the material is foam, the barbed end could be squished down and fitted through a hole that was the size of the rectangular connector. Once the barb is pushed entirely through the hole it is not easily pulled back out due to the barbed ends. The pin used to hold the boot onto the flaps utilizes this technology. The first model of the pin is shown below in Figure 19. The reason for the dual pins is that the foam AquaRunners (http://www.aquajogger.com/) that were ordered and used for the boots had three holes initially cut out of the bottom. Utilizing the first and the last of these holes led to the design below.

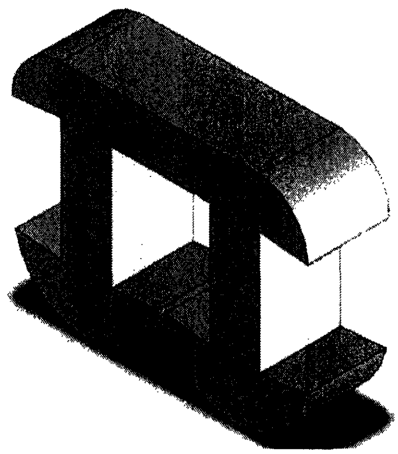


Figure 19: Solid Model of initial pin design

The first pin tested did not yield any observable data since the connector pieces on the initial flap designs ripped so easily. However, when this pin design was used with the flap design shown in Figure 15, several observations were made. The first is that the bottom two barbs were not made big enough and they slipped out of their housings rather easily. Another observation was that the large barb on the top of the pin also could be pulled down into its housing on the boot. Using the same overall design, the next pin prototyped increased the size of all of the barbs. Using this pin design, the barbed ends did not get pulled back through the housings, however the two connectors were ripped off entirely from the barbed ends. One way to solve this problem was to widen the connector pieces to increase the strength. However, it was decided to merge the two connector pieces into one big connector and make the two holes into one big one. Figure 20 shows the next design for the pin.

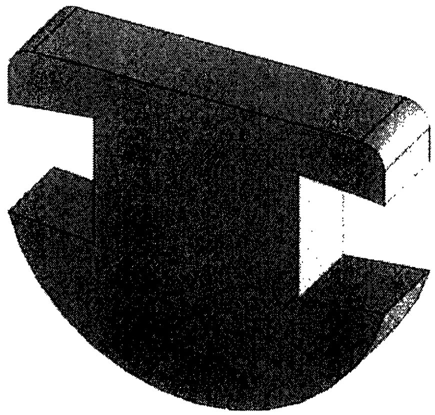


Figure 20: Solid model of the latest pin design

Using this pin required slight alteration of the flap design which is why Figure 17 shows the flaps with one large rectangular hole for the pin to slip through instead of the two that had been common on the previous prototypes.

2.3 The Final Design

The latest flap design, the latest pin design and the stoppers all can be assembled to create the final product which is shown below in Figures 21 and as an exploded view in Figure 22. It is important to note that the model of the boot in the below models is not entirely accurate. Since the boot is on the market already, a simple model estimating the dimensions was created for the purposes of putting together an assembly as shown below. All of the other components are accurate and are shown as they would be produced. To date, this final prototype has not been made and therefore has not been tested.

Figure 21 shows the preferred embodiment of the device. The Aquaflap 1 has flap structure 2 with left and right sides 2a and 2b. Structures 3a and 3b are attached to sides 2a and 2 b respectively, but they are not attached to the shoe 4. The AquaFlap 1 is attached to the shoe with the barbed foam pin, structure 5. Hence the structures freely bend downward so as to provide little resistance when the foot is raised, but they are resistant to bending upward when the foot is pressed down; thereby increasing resistance and enhancing the in-water exercise effect.

Figure 22 is an exploded view that shows the AquaFlaps 1 with structure 2 and the sides 2a and 2b connected by a middle portion 7 which has holes 8a and 8b which can be sized to control the amount of compliance of flaps 2a and 2b that a foot (not shown) fitting in the shoe 4 would incur as it is raised.

Center hole 15 also contributes to the compliance, but its primary function is for the connector 5's foam barb 17 to pass through, while hole 16 in the shoe 4 receives the foam barb 18, thereby holding the shoe 4 to the flaps 2

Side support structures 3a and 3b that prevent bending up when the shoe 4 is pressed down are held to the flaps 2a and 2b respectively by foam barbs 13a and 13b which fit in holes 8a and 8b.

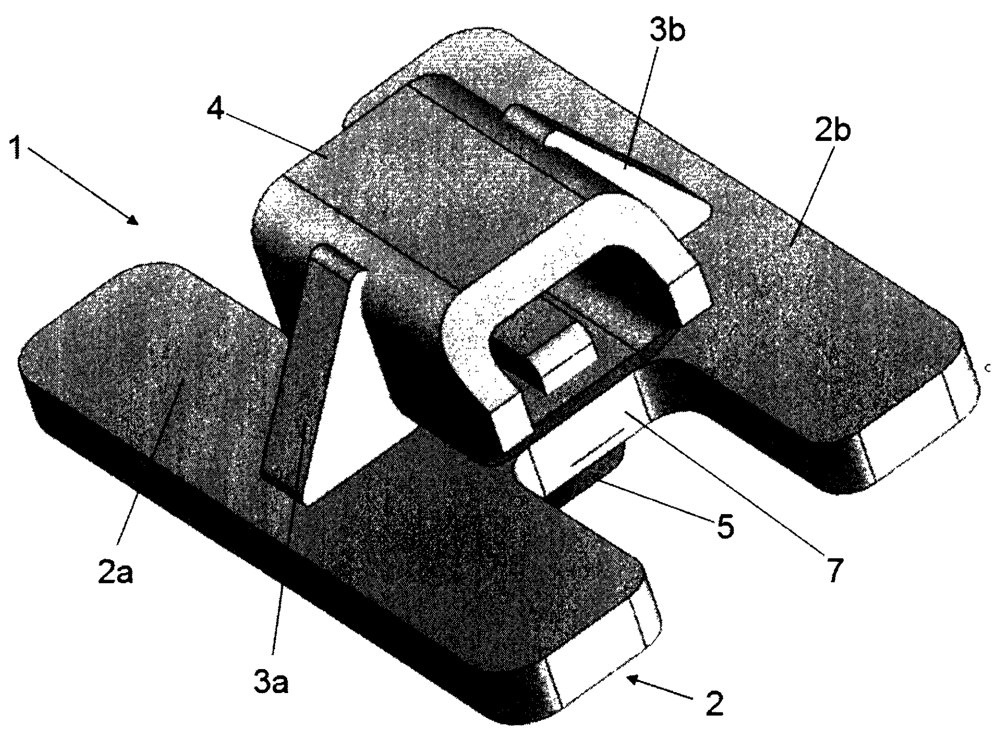


Figure 21: Solid model of assembled parts

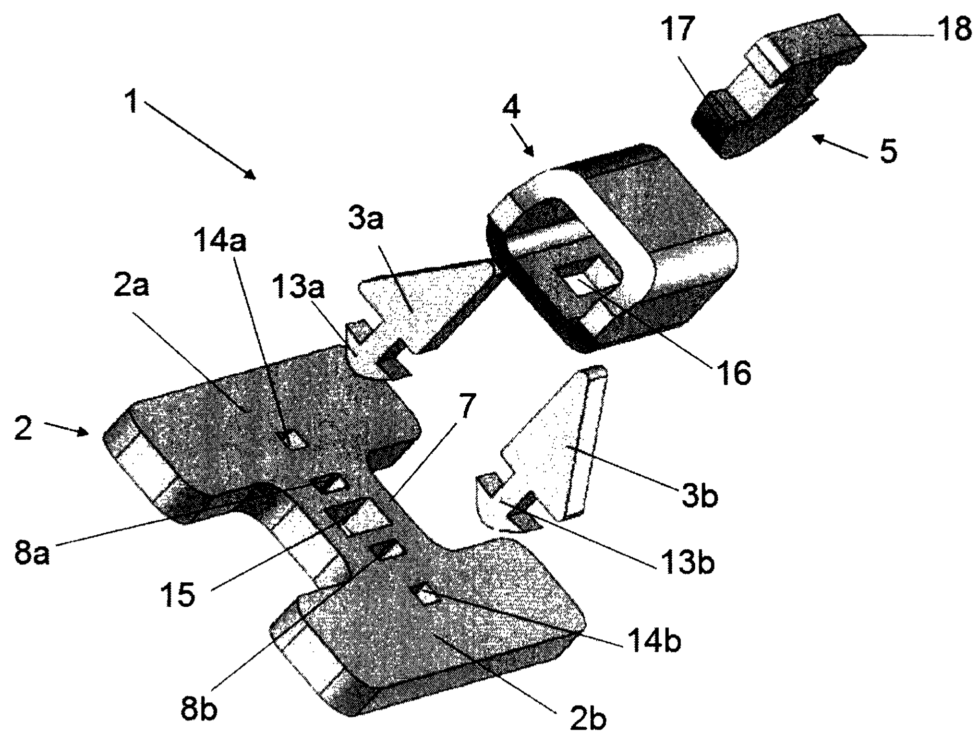


Figure 22: Exploded view of AquaFlap

2.4 Recommendations for Further Designing

As the final design pictured above has not been prototyped or tested, it is difficult to say whether there would need to be further improvements. One point of concern is how well the final pin design will hold the boot to the flaps. Potentially the pin may rip as did the second design. It may also get pulled back through its housing. If either of these are found to be problematic, a few things may be done to try and fix them. One option is to cut some holes in the flap section (2a and 2b above) of the product which will reduce the buoyancy while maintaining desirable drag. Furthermore, in place of the side structures 3 shown above, the base structure 2 could be molded to have one-way living hinges that enable it to be relatively stiff in the downward motion, and relatively compliant in the upward motion.

3.0 Future

3.1 Market

The initial intention was for these products, called AquaFlaps, to be used by hockey players for offseason training. However as the product developed and the design changed, the market became much bigger. The AquaFlaps now target anybody who may want to experience a low impact water workout. Thus, any pool facility could potentially make these available for use. Additionally, they could be used for rehabilitation exercises. The product will also be a great addition to the aquajogger belt already on the market and in use by many. People who use the belt would probably find the AquaFlaps useful for increasing their workout intensity while in the water. An added bonus is the price. Since it is all foam, the price will be very low and anyone will be able to buy them.

3.2 Production and Packaging

Since the product is made from flat foam parts, the production of this product will be rather simple. The foam can be extruded as a sheet and then die cut as is well-known to those skilled in the art of foam product manufacture. In this way, once the design is finalized, mass production will be very easy.

Another point to consider is how the AquaFlaps might be packaged. Since all of the pieces are flat foam cutouts, it makes this problem easier. Figure 23 illustrates a potential packaging arrangement. The benefits to this arrangement are that it will be very light and will be flat. The remaining question is whether the boot will be packaged with the rest of the device. Since the boot is already on the market, the flaps could be sold as an accessory.

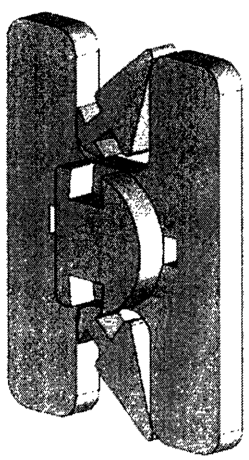


Figure 23: Potential packaging arrangement

4.0 Conclusions:

It has been proven through prototyping and testing that the concept and design presented work effectively. The AquaFlaps achieves the desired results; it provides added resistance when pushing the foot against the water and provides minimal resistance when pulling the foot back to the body. A few modifications still remain to be implemented but when the final design is successful, the product will be effective and marketable. It will be cheaper than what is on the market currently and comments made by passersby during testing indicate that the demand for such a device will be significant. A provisional patent was also filed for the AquaFlaps.

Appendix A – Original Thesis Proposal

Physical intelligence is the ability of the human organism to function in extraordinary accord with its physical environment. The body and all of its sensing, thinking, and moving is the basis of our experience in the world. Using experiential learning to investigate aspects of physical intelligence, it is proposed to design a piece of innovative exercise equipment.

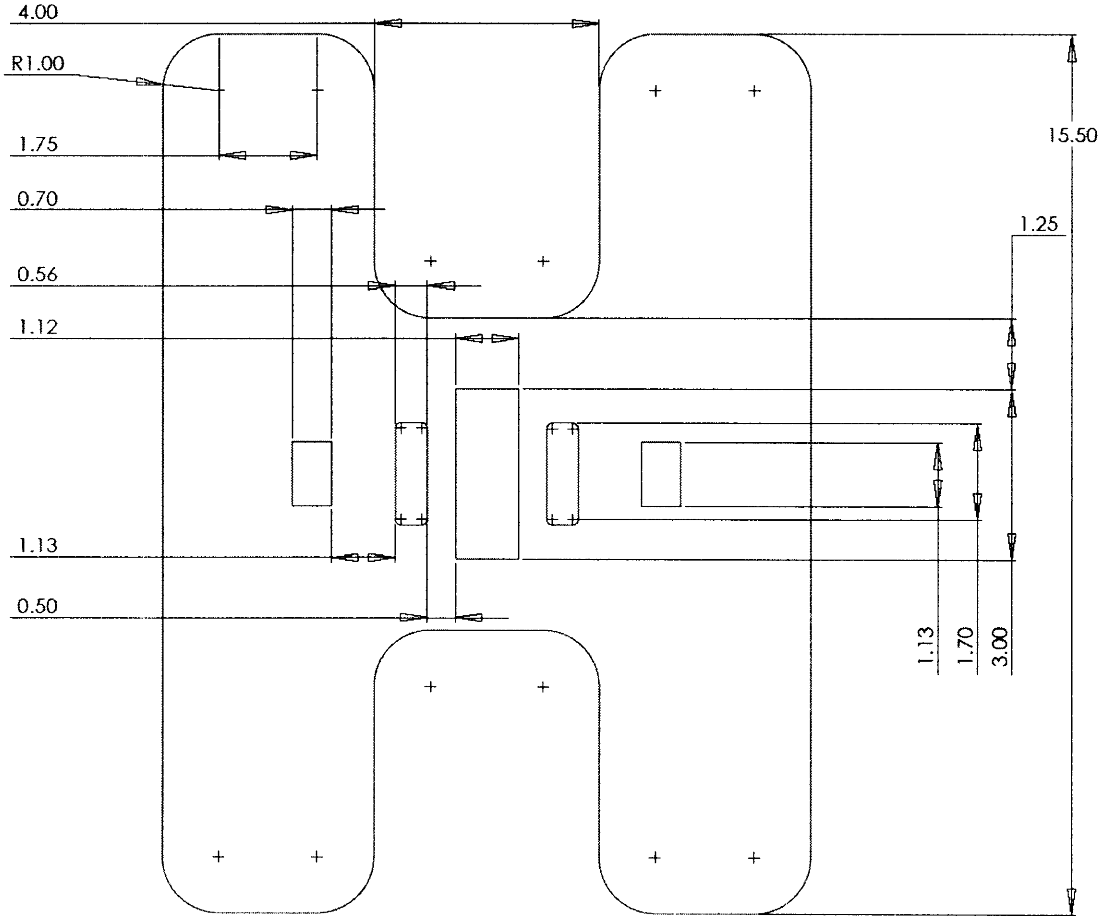
More specifically, over the years I have played hockey, I have never found an effective way in which to get ready for an upcoming hockey season. Running, rollerblading and biking have all failed to adequately prepare my legs for an upcoming season. Skating on ice is the only way I have ever been able to get into "hockey shape." With that said, I would like to design a machine or piece of exercise equipment that will better work the muscles used in ice skating while not actually on the ice. In addition I hope this piece of equipment will also be used for rehabilitative purposes to help recover from hockey related injuries. Research will be conducted to identify the major muscle groups involved in ice skating as well as the common injuries that occur in ice hockey.

My idea for a thesis is to design footwear or legwear that can be used in a swimming pool and that will provide resistances in different directions. This could be done by having body attachments with increased surface areas placed strategically to provide such resistances to the desired muscle group or body part. Keeping hockey as the sport of choice, this piece of equipment would be used in training for an upcoming season or if this turns out to be insufficient, would be used for rehabilitation of injuries related to ice hockey.

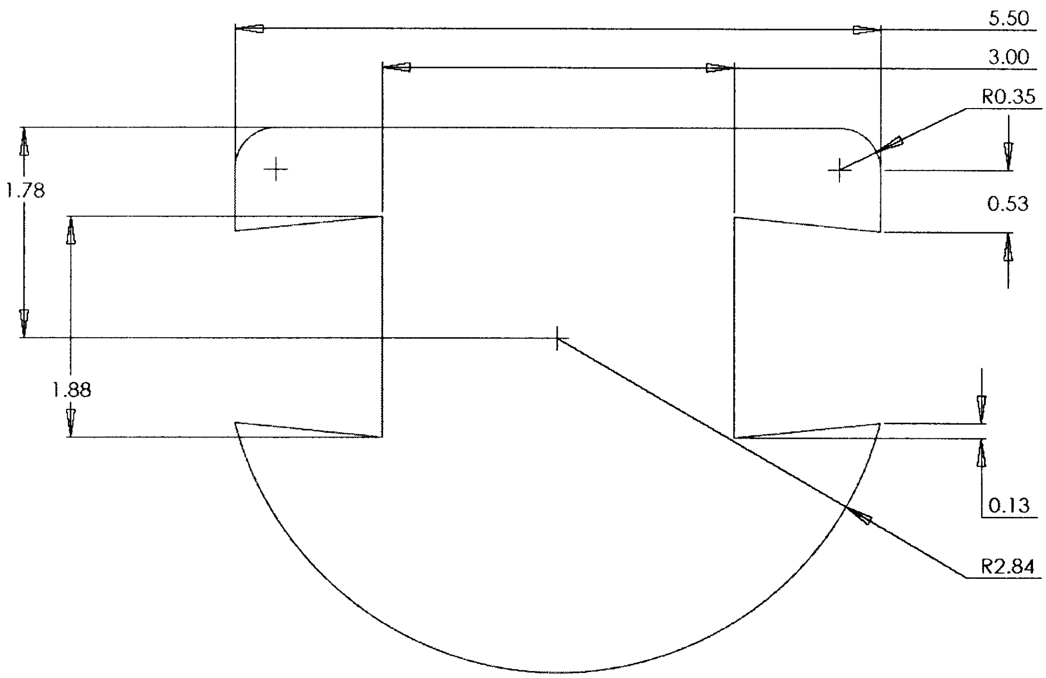
Appendix B – Outside Contributors

Professor Alexander Slocum contributed greatly in the designing and prototyping of this project. As mentioned in the report, he came up with the idea for the barbed tabs to snap fit pieces together as well as the idea to make the entire product out of foam. Additionally, he provided funding to purchase the AquaRunner boots.

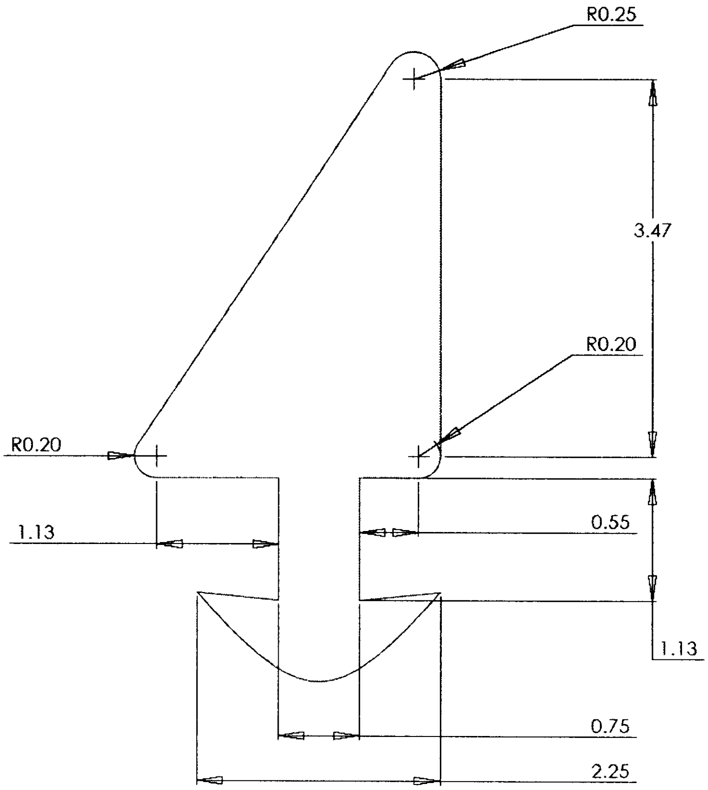
Appendix C – Final Design Specifications



The Dimensions of the Flap



The Dimensions of the Pin



The Dimensions of the Stopper

Appendix D – Technology Disclosure

AquaFlaps

The goal of the *AquaFlaps* is to provide added resistance to the feet while making the running motion through the water of a swimming pool. Specifically, the devices will provide added resistance while pushing out against the water while providing minimal resistance when pulling the leg back in to the body. Running through the water with just ones feet provides very little resistance and one must run for a very long time to achieve a reasonable workout. In addition, the time it takes to perform running laps in a pool would be greatly reduced with the use of *AquaFlaps*. These devices will also help with balance and core stabilization since the tendency of these foam devices is to float. There are many motions which a person may make with the *AquaFlaps*. It will be possible to stay stationary and simply pedal up and down and get a workout that way. It also will be possible to practice other motions like the skating motion of hockey or even simple motions required for those in rehab.

AquaFlaps are footwear with an added foam device to provide resistance. The portion that encloses the foot is a foam half-boot covering approximately half the foot with a strap around the ankle for support and tightening. The foam flaps which connect to the boot are actually one piece. This piece is strategically designed with holes in it to provide added flexibility. When pushing the leg outward against the water the flaps will extend out fully, appearing to be a large flat surface and thus providing more resistance. However when pulling the leg back into the body, the added flexibility will allow the foam flaps to bend and reduce the surface area which the water acts upon to provide the resistance. Additionally, the added buoyancy of the foam also makes it easier to pull the leg into the body. Since the foam boot and the flap section are actually two pieces, something else is needed to connect the two. To do this, a pin was designed to snap fit through holes in the boots and the flap section, holding everything together tightly and with good strength.

There are several devices which attempt to accomplish what the *AquaFlaps* does. There are foam boots much like the ones used in this product which are supposed to increase resistance on their own. Having tried these, it is very clear that there is a very minimal increase. There are rigid devices that can be strapped onto the feet and ankles to provide more resistance. These do not have the flexibility, however, to minimize the resistance in one direction and as result do not allow for a natural running motion. There is, nonetheless, a hinged device on the market that is supposed to do that. This device has four flaps hinged around a center plank with sandal-like straps to step into. The big problem with the four flaps is that unless the apparatus is pushed straight down, the flaps will not all come up and stop at the same time. This makes for a slightly uncomfortable experience as well as an awkward one when only three of the four flaps fold up. An additional downside to this product is the price and complexity. The device has four separate hinges of some sort and the flaps and device are made of a more rigid material. The *AquaFlaps* incorporate a simple design with only one hinge, built from the flexibility of the material itself. The material is also very cheap and thus the price will also be low.

The *AquaFlaps* unique properties of adding resistance in one direction but not in the other will make it a good product for personal training. It could be added to the collection of different water training equipment most pool establishments already have. The *AquaFlaps* may even be used in conjunction with other water training equipment like the aqua-jogger. The simple 2-D design of the *AquaFlaps* allows for easy cutting as well as easy shipping, as it can all be lay flat and assembled upon arrival. This will further decrease the price of the *AquaFlaps*. The simple, innovative design and low production costs give the *AquaFlaps* a distinct edge over the competition.

Appendix E – Provisional Patent

AQUATIC EXERCISE SHOE FLAPS

The present invention relates to foam structures that are attached to the bottom of a shoe worn while exercising in the water, where the structures freely bend downward so as to provide little resistance when the foot is raised, but they are resistant to bending upward when the foot is pressed down; thereby increasing resistance and enhancing the in-water exercise effect. The structures are called AquaFlaps.

STATEMENT REGARDING FEDERALLY FUNDED RESEARCH

No federal funds were used in the development of this invention

FIELD OF THE INVENTION

The present invention relates to aquatic exercise equipment, specifically aqua jogging equipment.

BACKGROUND

The goal of the AquaFlaps is to provide added resistance to the feet while making the running motion through the water of a swimming pool. Specifically, the devices will provide added resistance while pushing out against the water while providing minimal resistance when pulling the leg back in to the body. Running through the water with just ones feet provides very little resistance and one must run for a very long time to achieve a reasonable workout. In addition, the time it takes to perform running laps in a pool would be greatly reduced with the use of AquaFlaps. These devices will also help with balance and core stabilization since the tendency of these foam devices is to float. There are many motions which a person may make with the AquaFlaps. It will be possible to stay stationary and simply pedal up and down and get a workout that way. It also will be possible to practice other motions like the skating motion of hockey or even simple motions required for those in rehab.

AquaFlaps are footwear with an added foam device to provide resistance. The portion that encloses the foot is a foam half-boot covering approximately half the foot with a strap around the ankle for support and tightening. The foam flaps which connect to the boot are actually one piece. This piece is strategically designed with holes in it to provide added flexibility. When pushing the leg outward against the water the flaps will extend out fully, appearing to be a large flat surface and thus providing more resistance. However when pulling the leg back into the body, the added flexibility will allow the foam flaps to bend and reduce the surface area which the water acts upon to provide the resistance. Additionally, the added buoyancy of the foam also makes it easier to pull the leg into the body. Since the foam boot and the flap section are actually two pieces, something else is needed to connect the two. To do this, a pin was designed to snap fit through holes in the boots and the flap section, holding everything together tightly and with good strength.

There are several devices which attempt to accomplish what the AquaFlaps does. There are foam boots much like the ones used in this product which are supposed to increase resistance on their own. Having tried these, it is very clear that there is a very minimal increase. There are rigid devices that can be strapped onto the feet and ankles to provide more resistance. These do not have the flexibility, however, to minimize the resistance in one direction and as result do not allow for a natural running motion. There is, nonetheless, a hinged device on the market that is supposed to do that. This device has four flaps hinged around a center plank with sandal-like straps to step into. The big problem with the four flaps is that unless the apparatus is pushed straight down, the flaps will not all come up and stop at the same time. This makes for a slightly uncomfortable experience as well as an awkward one when only three of the four flaps fold up. An additional downside to this product is the price and complexity. The device has four separate hinges of some sort and the flaps and device are made of a more rigid material. The AquaFlaps incorporate a simple design with only one hinge, built from the flexibility of the material itself. The material is also very cheap and thus the price will also be low.

The AquaFlaps' unique properties of adding resistance in one direction but not in the other will make it a good product for personal training. It could be added to the collection of different water training equipment most pool establishments already have. The AquaFlaps may even be used in conjunction with other water training equipment like the aqua-jogger. The simple 2-D design of the AquaFlaps allows for easy cutting as well as easy shipping, as it can all be lay flat and assembled upon arrival. This will further decrease the price of the AquaFlaps. The simple, innovative design and low production costs give the AquaFlaps a distinct edge over the competition.

OBJECTS OF THE INVENTION

An object of the present invention, accordingly, is to provide a structure that is attached to a shoe worn while exercising in the water, where the structure provides little resistance to motion when the foot is raised, by bending downwards.

A further object is to provide the structure with hinges and stops to prevent the structure from bending upwards when the foot moves downwards.

SUMMARY

In summary, the invention embraces the use of a flat foam shape with cutouts for tabs to connect it to an aquatic show, such as an aquatic jogging shoe, and additional inserted structures that press up against the side of the shoe to prevent the structure from bending upwards when the foot is moved downwards, yet the structure can then bend downwards when the foot is raised. Hence downward motion of the foot tends to raise the user up in the water, and upward motion of the foot does not tend to drag the user under the water.

DRAWINGS

The invention will now be described with reference to the drawings on pg. 22 in which:

Fig. 21 is an isometric drawing of the structure attached to an aquatic shoe;

Fig. 22 is an exploded view isometric of the structure and shoe.

PREFERRED EMBODIMENT(S) OF THE INVENTION

Fig. 21 shows the preferred embodiment of the invention which is made from flat foam parts, which can be extruded as a sheet and then die cut as is well-known to those skilled in the art of foam product manufacture. The Aquaflap 1 has flap structure 2 with left and right sides 2a and 2b. Structures 3a and 3b are attached to sides 2a and 2 b respectively, but they are not attached to the shoe 4. The AquaFlap 1 is attached to the shoe with foam barbed structure 5. Hence the structures freely bend downward so as to provide little resistance when the foot is raised, but they are resistant to bending upward when the foot is pressed down; thereby increasing resistance and enhancing the in-water exercise effect.

Fig. 22 is an exploded view that shows the AquaFlaps 1 with structure 2 and the sides 2a and 2b connected by a middle portion 7 which has holes 8a and 8b which can be sized to control the amount of compliance of the flaps 2a and 2b as a foot (not shown) that would fit in the shoe 4 would incur as it is raised.

Center hole 15 also contributes to the compliance, but its primary function is for the connector 5's foam barb 17 to pass through, while hole 16 in the shoe 4 receives the foam barb 18, thereby holding the shoe 4 to the flaps 2

Side support structures 3a and 3b that prevent bending up when the shoe 4 is pressed down are held to the flaps 2a and 2b respectively by foam barbs 13a and 13b which fit in holes 8a and 8b.

The user is assumed to wear a buoyant waist belt, as is common when aqua jogging. This prevents the user from being in the position where their feet are more buoyant that their mid section which could cause panic. Accordingly, to minimize buoyancy while maintaining desirable drag, the flaps 2a and 2b could be perforated with centimeter-diameter holes (not shown).

Furthermore, in place of the side structures 3, the base structure 2 could be molded to have one-way living hinges that enable it to be relatively stiff in the downward motion, and relatively compliant in the upward motion.

Further modifications of the invention will also occur to persons skilled in the art, and all such are deemed to fall within the spirit and scope of the invention as defined by the claims.

What is claimed is:

1. A structure that can be attached to an aquatic shoe comprising a flat base with two sides joined by a center region, said center region having holes to receive connecting barbs that hold the structure to said shoe.
2. The structure of claim 1 further comprising upward bending restricting side structures that are held with barbs to said structure.
3. The structure of claim 2 where the elements are made of foam.

ABSTRACT

A foam structure that is attached to the bottom of a shoe worn while exercising in the water, where the structure freely bends downward so as to provide little resistance when the foot is raised, but is resistant to bending upward when the foot is pressed down; thereby increasing resistance and enhancing the in-water exercise effect. The structure is called AquaFlaps.